CLAIMS

What is claimed is:

1. A free space optical apparatus, comprising:

an optical fiber to propagate at least a portion of an incoming light beam; and

a ferrule coupled to the optical fiber, wherein the ferrule includes a plurality of regions to direct one or more portions of the incoming light beam in one or more predetermined directions, an amount of light in each of the one or more portions being a function of an alignment between the incoming light beam and the apparatus.

2. The apparatus of claim 1, wherein at least one region of the plurality of regions includes a diffractive optical element.

3. The apparatus of claim 2, wherein the diffractive element comprises a surface grating.

4. The apparatus of claim 2, wherein the diffractive optical element comprises a hologram.

5. The apparatus of claim 4, wherein the hologram comprises a volume phase grating.

6. The apparatus of claim 2, wherein the diffractive element diffracts incident light so that substantially all the diffracted light is in a preselected order.

7. The apparatus of claim 2, wherein a first region and a second region of the plurality of regions each include a diffractive optical element, each diffractive element to diffract incident light so that substantially all the light diffracted by that diffractive element is in a preselected diffraction order, the direction of the preselected diffraction order of the first region being different from that of the second region.

8. The apparatus of claim 1, wherein at least one region of the plurality of regions includes a reflective facet.

9. A free space optical system, comprising:

an optical fiber having a first end to receive at least a portion of an incoming light beam;

a communications detector, coupled to a second end of the optical fiber, to receive the received portion of the incoming light beam via the optical fiber;

a ferrule fitted to the first end of the optical fiber, wherein the ferrule includes a plurality of regions to direct one or more portions of the incoming light beam in one or more predetermined directions, an amount of light of each of the one or more portions being a function of an alignment between the incoming light beam and the system; and

a plurality of tracking detectors arranged to receive the one or more portions directed by the plurality of regions.

10. The system of claim 9 wherein at least one of the plurality of tracking detectors is a photodiode.

11. The system of claim 9 wherein at least one of the plurality of tracking detectors is an avalanche photodiode.

12. The system of claim 9, further comprising collection optics arranged to redirect the portions directed by the plurality of regions to the plurality of tracking detectors.

13. The system of claim 9 further comprising a lens coupled to the first end of the optical fiber, wherein light directed toward a cladding of the optical fiber will be redirected to a core of the optical fiber by the lens.

14. The system of claim 9, wherein at least one region of the plurality of regions includes a diffractive optical element.

15. The system of claim 14, wherein the diffractive element comprises a surface grating.

16. The system of claim 14, wherein the diffractive optical element comprises a hologram.

17. The system of claim 16, wherein the hologram includes a volume phase grating.

18. The system of claim 14, wherein the diffractive element diffracts incident light so that substantially all the diffracted light is in a preselected order.

19. The system of claim 14 further comprising a mount having an opening aligned with the first end of the optical fiber, wherein the plurality of tracking detectors are attached to mount.

20. The system of claim 14 wherein the incoming light beam has a pedestal distribution.

21. A free space optical system, the system comprising:

an optical fiber having a first end to receive at least a portion of an incoming light beam;

a communications detector, coupled to a second end of the optical fiber, to receive the received portion of the incoming optical signal via the optical fiber; and

a multi-cell optical detector coupled to the optical fiber so that the first end of the optical fiber is fitted to an opening of the multi-cell optical detector, the multi-cell optical detector being arranged so that an amount of light incident on a cell of the multi-cell optical detector is a function of an alignment between the incoming light beam and the system.

22. The system of claim 21, wherein the multi-cell optical detector is a quadrant detector, the opening being located at a point where the quadrant detector's cells meet.

23. The system of claim 21, further comprising a lens coupled to the first end of the optical fiber, wherein light directed toward a cladding of the optical fiber will be redirected to a core of the optical fiber by the lens.

24. A free space optical system, comprising:

a plurality of optical fibers, wherein the plurality of optical fibers include a first fiber having a first end to receive at least a portion of an incoming light beam, and having a set of fibers arranged about the first fiber, the set of fibers being shaped to substantially conform to at least a portion of an outer surface of the first fiber, the set of fibers having a first set of fiber ends arranged to receive light of the incoming light beam that is not incident on the first end of the first fiber so that an amount of light incident on each fiber of the set of fibers is a function of an alignment between the incoming light beam and the system;

a communications detector coupled to a second end of the first fiber; and

a set of tracking detectors, wherein each tracking detector of the set of tracking detectors is coupled to a corresponding fiber of the set of fibers, each tracking detector to detect any light propagated by its corresponding fiber of the set of fibers.

25. The system of claim 24 wherein at least one of the set of tracking detectors is a photodiode:

26. The system of claim 24 wherein at least one of the set of tracking detectors is an avalanche photodiode.

27. The system of claim 24 wherein the first end of the first fiber extends beyond the first set of fiber ends.

28. The system of claim 24, further comprising a lens coupled to the first end of the first fiber, wherein light directed toward a space between the fibers of the plurality of optical fibers will be redirected to a core of the first fiber by the lens.

29. The system of claim 24, further comprising a diffractive optical element disposed between a source of the incoming light beam and the plurality of optical fibers, wherein the diffractive optical element to redirect at least a portion of the incoming light signal to the set of fibers.

30. The system of claim 29, wherein the diffractive optical element includes a radial transmission grating with a non-diffractive region aligned with the first fiber so that light of the incoming light beam directed toward the first fiber will pass through the non-diffractive region and strike the first fiber.

31. A free space optical apparatus, comprising:

a first optical fiber to receive at least a portion of an incoming light beam;

a plurality of optical fibers not including the first optical fiber, wherein the plurality of optical fibers to receive light of the incoming light beam that is not incident on the first optical fiber; and

a mounting plate having an opening to receive the first optical fiber, and having a plurality of grooves to receive the plurality of optical fibers.

32. The apparatus of claim 31, wherein the mounting plate has a refractive index that is substantially the same as that of the first optical fiber and the plurality of optical fibers.

33. The apparatus of claim 31, wherein the plurality of grooves are shaped to receive protrusions formed on ends of the plurality of optical fibers.

34. The apparatus of claim 31, wherein the plurality of optical fibers each have an angled tip that serves as a reflective surface to couple incident light to one of the plurality of optical fibers.

35. The apparatus of claim 31, wherein at least one groove of the plurality of grooves has sidewalls that constrain the location of one of the plurality of optical fibers.

36. The apparatus of claim 31, wherein the incoming light beam has a pedestal distribution.

37. A free space optical apparatus, comprising:

an optical fiber having a first section and a second section, wherein the first section to receive at least a portion of an incoming light beam and wherein the second section to propagate an outgoing light beam; and

a ferrule coupled to the optical fiber, wherein the ferrule includes a plurality of regions to direct one or more portions of the incoming light beam that are not incident on the optical fiber in one or more predetermined directions, an amount of light in each of the one or more portions being a function of an alignment between the incoming light beam and the apparatus.

38. The apparatus of claim 37, wherein each region of the plurality of regions includes a diffractive optical element.

39. The apparatus of claim 38, wherein the diffractive element comprises a surface grating.

40. The apparatus of claim 38, wherein the diffractive optical element comprises a hologram.

41. The apparatus of claim 40, wherein the hologram comprises a volume phase grating.

42. The apparatus of claim 38, wherein the diffractive element diffracts incident light so that substantially all the diffracted light is in a preselected order.

43. The apparatus of claim 38, wherein a first region and a second region of the plurality of regions each include a diffractive optical element, each diffractive element to diffract incident light so that substantially all the light diffracted by that diffractive element is in a preselected diffraction order, the direction of the preselected diffraction order of the first region is different from that of the second region.

44. The apparatus of claim 37, wherein at least one region of the plurality of regions includes a reflective facet.

45. The apparatus of claim 37, wherein the incoming light beam has a pedestal distribution.

46. A method, comprising:

receiving an incoming light beam using an apparatus that includes an optical fiber and a ferrule fitted to the optical fiber, the ferrule having a plurality of regions; and

propagating light of the incoming light beam that is incident on the optical fiber to a communications detector; and

redirecting light of the incoming light beam that is incident on the plurality of regions of the ferrule to at least one of a plurality of tracking detectors, wherein each region of the plurality of regions redirects incident light of the incoming light beam to a corresponding preselected tracking detector of the plurality of tracking detectors.

47. The method of claim 46, wherein redirecting light of the incoming light beam comprises diffracting light that is incident on a region of the plurality of regions using a diffractive optical element.

48. The method of claim 46, wherein redirecting light of the incoming light beam further comprises reflecting light that is incident on a region of the plurality of regions using a reflective coating applied to that region.

49. The method of claim 46, wherein redirecting light of the incoming light beam further comprises using collection optics to redirect light from the plurality of regions to the plurality of tracking detectors.

50. The method of claim 46, wherein the incoming light beam has a pedestal distribution.

51. A method, comprising:

attaching a multi-cell detector to an optical fiber to form an assembly;

arranging the assembly to receive an incoming light beam so that at least a portion of the incoming light beam is incident on a tip of the optical fiber and light of the incoming optical signal that is not incident on the tip is incident on the multi-cell detector, the amount of light incident on each cell of the multi-cell detector being dependent on an alignment between the assembly and the incoming light beam;

propagating, via the optical fiber, light of the incoming light beam that is incident on the optical fiber to a communications detector; and

adjusting the alignment between the assembly and the incoming light beam using output signals from the multi-cell detector.

52. The method of claim 51, wherein the multi-cell detector comprises a quadrant detector.

53. The method of claim 51, wherein the incoming light beam has a pedestal distribution.